This case was developed jointly by APPL and the Goddard Systems Management Office for the purpose of discussion and training. It is not a comprehensive account of the VCL project and should not be quoted as such. A more complete story of VCL is available on the APPL website**:** **www.appl.nasa.gov**

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Lessons in Project Management: The Vegetation Canopy Lidar (VCL)

Thrilling Science

A thrill of excitement rippled through the entire earth science community when the VCL project was announced. Imagine…mapping the vegetation of the entire Earth in three-dimensional detail, including vertical dimensions of forests. Information supplied by the Vegetation Canopy Lidar (VCL) mission would provide a direct way to identify degraded areas, pinpoint areas of regrowth, explain how a forest ages, and monitor important habitat areas.

An AO had been issued for the first Earth System Science Pathfinder (ESSP) spaceflight mission with a launch date of January 2000. In response, the University of Maryland, College Park (UMCP) and GSFC Laboratory for Terrestrial Physics (LTP) offered a joint proposal – the VCL – with split responsibility for its creation. The VCL was to provide five to 10 times more accurate estimates of canopy height, which would be used to estimate total biomass, the major reservoir of carbon in terrestrial ecosystems that can be quickly released by disturbances such as fires or land usage changes. The area of tropical land surface surveyed would increase by more than 200,000 times as the VCL sampled closed-canopy forests from 65 degrees north latitude to 65 degrees south latitude in its two-year lifecycle. In addition, VCL would offer a new measurement of the texture and the aerodynamic properties of Earth's surface, a critical factor in climate modeling and weather prediction.

Ambitious Objectives

In the AO, the VCL collaborative team said they could build the spacecraft within 36 months at a cost of $60 million. With the combination of great science offered at a reasonable price in a quick timeframe, the AO was awarded to the VCL team in March 1997.

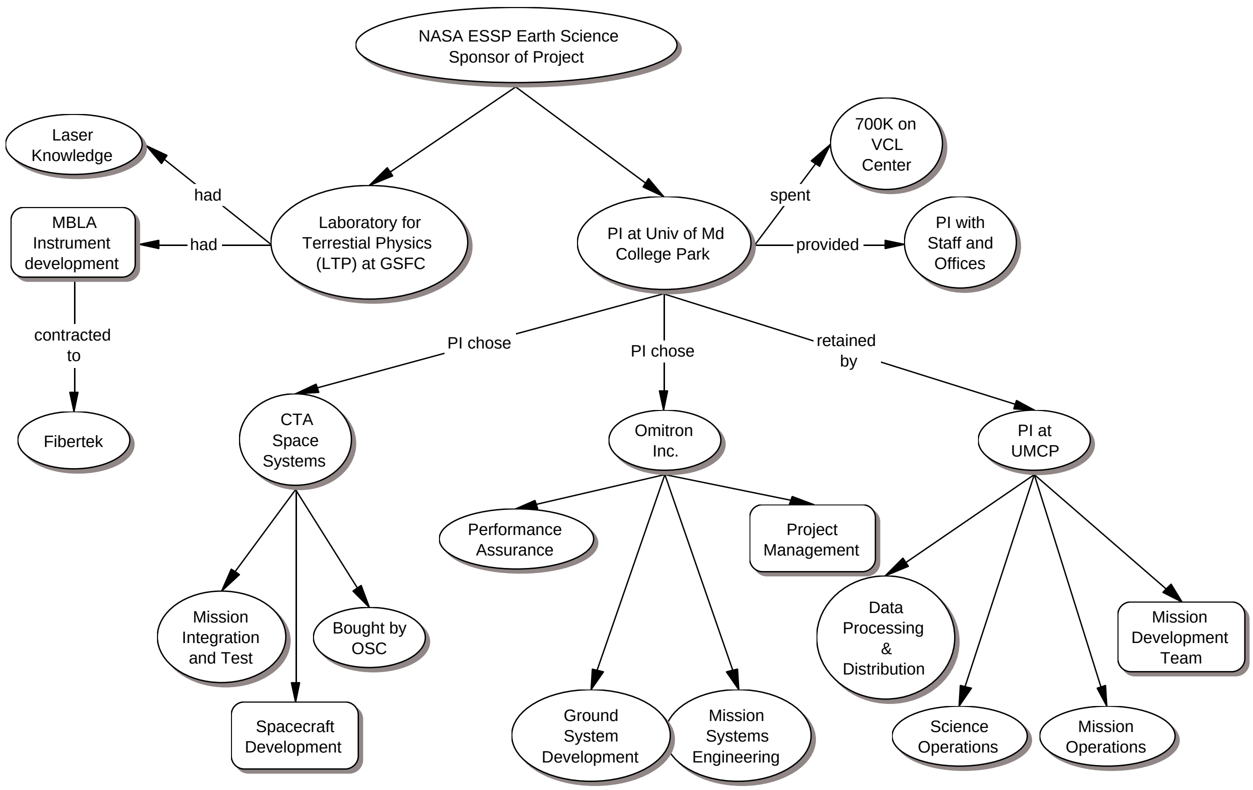
The VCL mission was a category 1 science. The main instrumentation, to be built by LTP, depended on lidar technology. Lidar, or laser altimetry, had been used since the early 1970s. But only in the last decade had technological advances resulted in the development of reliable and accurate spaceborne sensors, including the Mars Observer Laser Altimeter and the Shuttle Laser Altimeter.

VCL's Multi-Beam Laser Altimeter (MBLA) would advance lidar technology by also recording the "waveform" of the returned signal. VCL would be the first multi-beam waveform-recording lidar to fly in space. The VCL was planned to hold five lasers, each sending a beam to cover an area 75 feet across. By spacing the five beams a little over a mile apart, each VCL orbit would sample an area five miles across.

Complex Organization

The work was divided between two main areas: the PI and his team at the University of Maryland (College Park) were responsible for mission operations, science operations, and data processing/distribution; GSFC's LTP was responsible for building the MBLA.

The actual work went several layers deeper. Because UMCP's PI was inexperienced in spaceflight hardware development, he contracted project management to Omitron Inc., which also took on responsibility for mission systems engineering, ground system development, and performance assurance. For the spacecraft development and mission integration and test, the PI selected CTA Space Systems (later bought out by Orbital Sciences Corporation). LTP, in turn, subcontracted Fibertek Inc. to develop the MBLA laser transmitter.



From the start, this multi-layered management system presented a fair measure of confusion. At first, the Center had not even considered this a GFSC project, because the PI was from UMCP and the spacecraft was being built at LTP. VCL and MBLA were virtually invisible to GSFC upper management. In addition, the UMCP team had assumed that the MBLA would be Government Furnished Equipment (GFE), and that GFSC would deliver it. Although GSFC was legally bound to deliver the instrument to UMCP, under the terms of the AO, the LTP was effectively operating as UMCP's subcontractor. Therefore, the MBLA was not GFE under the mission contract between the EESP Program Office and UMCP.

During confirmation, the GSFC Resource Analysis Office reported to the Confirmation Assessment Review team, not GSFC management. This put the RAO in a project advocacy role and their cost analysis relied on the project's favorable assumptions. This led to an estimate close enough to the project's to pass muster. Although pushing for better management, they did not expose the overly optimistic expectations of the instrument technology development. Both HQ selection and confirmation offices relied on the GSFC involvement, and believed it would be significantly greater than just the development of the MBLA by the LTP.

VCL Chronology

Date	Event	Est. Launch	Est. Cost
July ’96	First ESSP AO issued, AO 96-MPTE-01		
August ’96	VCL Step 1 Proposal submitted to NASA		
December ’96	VCL Step 2 Proposal submitted to NASA	January ’00	$60M
March ’97	VCL selected as the first ESSP mission		
May ’97	Definition Phase start		
August ’97	VCL notified that the NASA SELVS Pegasus launch service is not available. Directed to maintain dual launch vehicle compatibility.		
Oct. ’97	Mission Concept Review		
January ’98	Spacecraft and instrument Preliminary Design Reviews		
February ’98	Mission Design Review		
March ’98	Confirmation Review	April ’00	$60M
April ’98	Athena Launch Service approved for VCL	May ’00	$63M
May ’98	Implementation Phase start		
June ’98	Launch Site moved to Kodiak Island, Alaska, from VAFB	September ’00	$67.5M
August ’98	Spacecraft and Instrument Critical Design Reviews		
September ’98	Ground and Data System Critical Design Review		
June ’99	ESSP Program Review – Mission viability concerns		
July ’99	Instrument reliability assessment done by GSFC Engineering Directorate		
November ’99	GSFC Tiger Team Review		
December ’99	Mission Operations Review		
January ’00	GSFC takes responsibility for managing the mission – **P. Sabelhaus, PM**		

A Question of Experience:

UMCP’s PI had no experience in flight system development. The PM named in the proposal had 32 years of experience, but never managed development of a flight mission. Recognizing this weakness, the PI named a new PM. Stronger technically, he lacked project management skills and tried to be both PM and mission systems engineer. His project management experience was with large, high-cost missions with a deep support staff, and he was unsure how to run a fast-paced, streamlined project like this one. Goddard’s Instrument Manager was strong technically, but lacked management skills or experience. The Business Manager at UMCP had never managed finances, procurements, or other business functions for a space flight project, and UMCP had already committed to spending $700,000 on VCL control and data management centers.

To an outside observer, the teams might have had a chance to overcome even these formidable drawbacks given strong leadership. However, there was no unifying institution to recognize, monitor, and address problems. Development was organized into teams rather than through a streamlined central management structure. The PM was in a different location from the PI and the teams for instrument and spacecraft development, and did not insist on locating the core team members at the same place, despite the advice of the Program Office.

Technology Snags

In August 1997, the teams learned that the Pegasus launch service that was to take VCL into space would not be available. They now had to maintain dual launch vehicle capability, which added considerably to the cost of the project. And in June 1998, the launch site was moved from VAFB to Kodiak Island, Alaska.

Then Fibertek, building the laser transmitter, was unable to move beyond a research mode. Its engineers had no background or discipline in building flight hardware, so they were designing by costly trial and error. The Instrument Manager decided to switch his course, and adopted a promising design developed at the American University. The engineers at Fibertek, although frustrated by their failed efforts, resisted building someone else's design. The spacecraft development strategy also dropped behind schedule. The spacecraft contractor was focused on projects that were more important strategically to the company, and had only a lean engineering team and little bench strength to spare for the VCL.

By June 1999, serious mission viability concerns were raised, and an ESSP Program Review was ordered, followed in the next few months by a GSFC Tiger Team Review and a Mission Operations Review.

The Decision Point: Your Assignment

It's January 2000. Goddard has been asked to take direct control of the project. You are requested to assume the task of Project Manager. After completing a thorough reevaluation of the project, you discover that the cost estimate is 150% more than original projections, the schedule will take a year longer than anticipated, and the risk of technology readiness is considerably beyond project expectations. Your recommendation is due to the Program Office in two weeks. What should you do?

1. Discuss these options within your group. List reasons for choosing each option and decide which one you would recommend.
   a) Push back on the team to give you what's doable with the current resources.
   b) Firm up the new estimates, take it to HQ, and request the additional funding to complete the project "the right way."
   c) Terminate the project as undoable as defined and financed.
   d) Something else – be specific.

2. List two or three key questions you would like to ask the Project Manager at this point in the project that would help you make your decision.